STATE OF NEW YORK
DEPARTMENT OF CONSERVATION
WATER POWER AND CONTROL COMMISSION

SALINE WATERS IN NEW YORK STATE

Long Island, Staten Island and Manhattan

By
N. J. LUSCZYNSKI AND J. J. GERAGHTY

Upstate New York

By
E. S. ASSELSTINE AND I. G. GROSSMAN

Prepared by the
U. S. GEOLOGICAL SURVEY
In cooperation with the
NEW YORK WATER POWER AND CONTROL COMMISSION

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AND

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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NEW YORK WATER POWER AND CONTROL COMMISSION
NASSAU COUNTY DEPARTMENT OF PUBLIC WORKS
SUFFOLK COUNTY BOARD OF SUPERVISORS
AND
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STATE OF NEW YORK

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Saline Waters In New York State

INTRODUCTION

In connection with studies of the practicability of conversion of saline water to fresh water, the U. S. Geological Survey assembled data on the occurrence, distribution, quantity, and chemical quality of saline waters as of 1955 for a report entitled, "Preliminary survey of the saline water resources of the United States" to be released when completed as a U. S. Geological Survey Water Supply Paper 1374. This report comprises data for New York State. *Saline water* is defined herein as any mixture of fresh and salt water having more than 1,000 parts per million (ppm) of dissolved solids. In the Nation as a whole there are, of course, all gradations of salinity from 1,000 ppm up to the 30,000 to 35,000 ppm characteristic of sea water, and the even higher salinities of certain natural brines. Sea water, and other water of comparable salinity, will be referred to here as "sea water" or "high-chloride water".

This report contains two parts: one for Long Island, Staten Island, and Manhattan, N. Y., and the other for Upstate New York. Figure 1 shows the locations of the places named and important occurrences of saline water in and near Long Island. Tables 1 and 2 list, respectively, well data and chemical analyses for selected wells in Long Island, Staten Island, and Manhattan, N. Y.; tables 3 and 4 list, respectively, well data and chemical analyses for selected wells in Upstate New York. For many samples, only the chloride concentration and not the total dissolved solids has been determined. However, it is safe to assume that the total dissolved solids in natural water are substantially in excess of 1,000 ppm where the chloride is at or nearly at this concentration.

LONG ISLAND, STATEN ISLAND, AND MANHATTAN

By

N. J. Lusczynski and J. J. Geraghty

Geologic and Hydrologic Conditions

With the exception of large quantities of water supplied to Kings and Queens Counties from New York City's upstate reservoirs, nearly all fresh water used on Long Island is taken from wells. Several extensive formations, consisting of sand, gravel, and clay and ranging in total thickness from a few feet in northern Queens County to more than 2,000 feet in southern Suffolk County, underlie Long Island. Four main aquifers, all interconnected hydraulically to a greater or lesser degree, have been identified (Veatch, 1906; Fuller, 1914; Suter, de Laguna, and Perlmutter, 1949). These aquifers, from youngest to oldest (top to bottom), are the upper Pleistocene deposits, in which ground water is generally unconfined, and three units in which water occurs under artesian pressure—the Jameco gravel, of Pleistocene age, and the Magothy (?) formation and the Lloyd sand member of the Raritan formation, both of Late Cretaceous age. Except for some artificial recharge through wells and basins (Johnson, 1948), these aquifers are replenished entirely by infiltration of precipitation. Under natural conditions, fresh water flows into and through the formations, ultimately discharging into the sea. In addition, an appreciable quantity of fresh water reaches the ocean after discharging into the lower reaches of the many small streams in Long Island; such water includes overland runoff plus the portion of the outflow from the ground-water reservoirs that does not discharge directly into the sea.

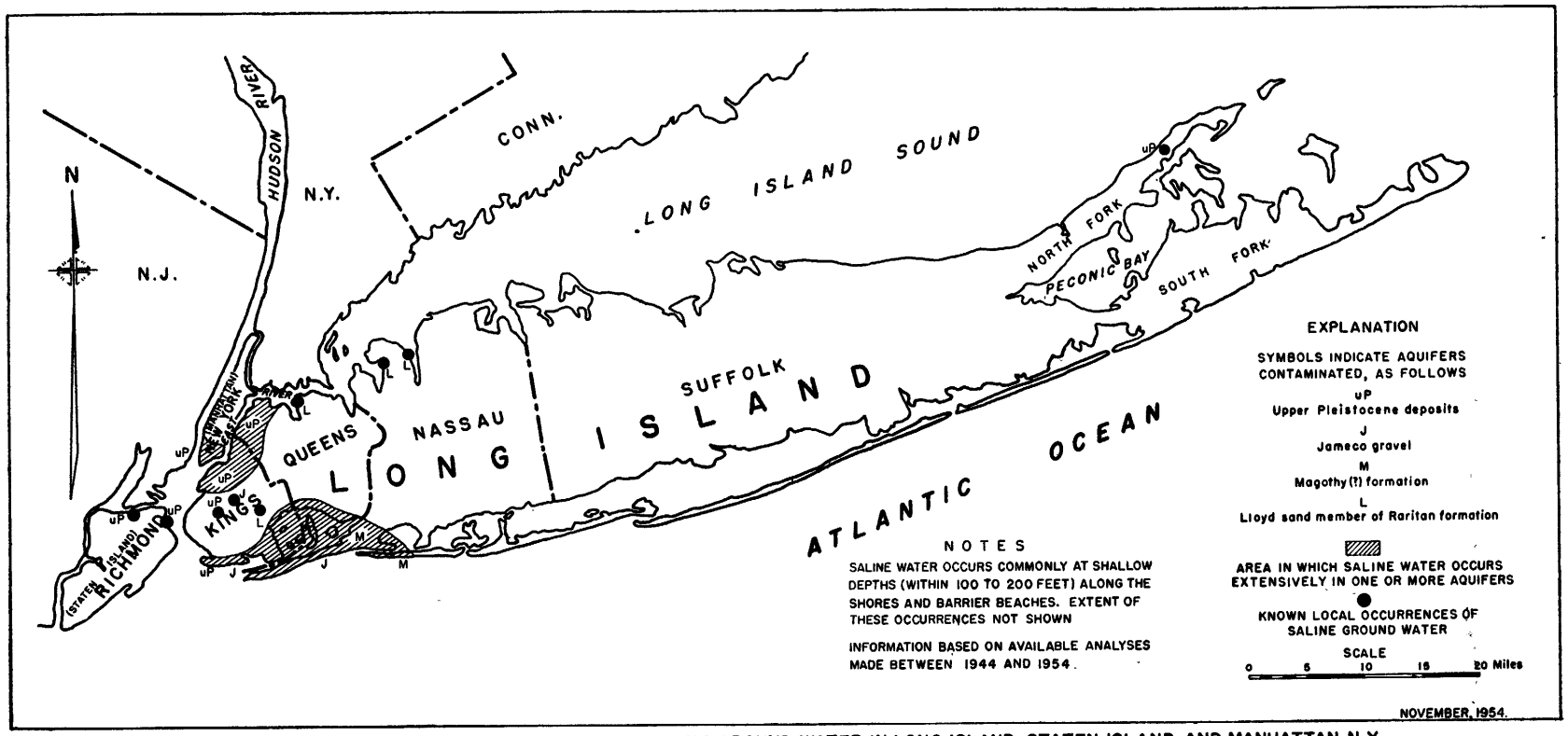

Figure 1.—MAP SHOWING OCCURRENCES OF SALINE GROUND WATER IN LONG ISLAND, STATEN ISLAND, AND MANHATTAN, N.Y.

In Staten Island (Richmond County) most of the water used for public supply is obtained from New York City's upstate reservoirs, lesser amounts being pumped from wells on the Island (Perlmutter and Arnow, 1953). The water-bearing formations consist of unconsolidated deposits of Late Cretaceous and Pleistecene age, similar to those on Long Island. The total thickness of these deposits ranges from 5 to 400 feet. As on Long Island, local precipitation is the main source of fresh-water replenishment to them.

In the southern part of Manhattan (New York County), bordered on three sides by the high-chloride waters of the Hudson and East Rivers, are sand, gravel, and clay of Pleistocene age resting on bedrock. A number of industrial wells obtain water from these deposits, which are as much as 250 feet thick in places (Perlmutter and Arnow, 1953).

Saline Water in Long Island

Saline water in Long Island occurs in the zones of diffusion or mixing between fresh water and sea water (1) in the lower reaches of the many streams and creeks, and (2) underground—at or near shore, or offshore, in the four water-bearing formations. Figure 1 shows two areas in western Long Island, and also one in southern Manhattan, where saline ground water occurs extensively. In addition, it shows the locations of individual wells or well fields outside these areas where saline water has been reported.

Fresh water in the streams and underground formations at most localities in Long Island contains less than 100 ppm of dissolved solids, whereas sea water surrounding Long Island ranges in salinity from 25,000 to more than 30,000 ppm in the open Atlantic Ocean, and from 20,000 to 30,000 ppm in Long Island Sound. Water in most parts of the East River, Peconic Bay, and the several large bays along the south shore of the Island has a salinity appreciably above 10,000 ppm.

The location, extent, and thickness of the bodies of saline water between the fresh water and sea water are of primary interest to this discussion. Fresh water, moving continuously down the streams, eventually comes in contact with and mixes with sea water. In the streams, these contact areas are in the lower reaches, near the mouths; they are not stationary, however, but move various distances up and down stream, depending on the streamflow and the tide level. Saline water also occurs underground along the shores, and offshore in the unconsolidated deposits, at various depths below the land surface. In the unconsolidated deposits the bodies of saline water are somewhat more extensive than in the streams, and their positions shift back and forth much more slowly.

In most areas of Long Island, saline water in the several formations occurs essentially under natural conditions near shore and offshore because artificial withdrawals up to the present time have been relatively small. In some parts of western Long Island, chiefly in Queens and Nassau Counties, saline water may be moving landward or upward, doubtless very slowly, as withdrawals increase year after year. There are few or no data available on the rate of such movement. In a few places, chiefly in Kings County, fresh ground water has become salty as a result of heavy and increased withdrawals during the thirties and early forties.

Deposits of Recent and late Pleistocene age on the barrier beaches and along the shores of the Island at many places contain saline water under more or less natural conditions. Its presence in these areas is not the result of progressive encroachment or invasion. The saline water is usually at depths less than 100 feet below the land surface, and at least some fresh water is present at greater depths in the deeper formations. A few analyses of saline water from the shallow bodies show chloride concentrations up to 5,000 ppm. Detailed information on the extent of these bodies is not available.

In the North and South Forks of eastern Suffolk County, each of which is nearly surrounded by sea or bay water, the water table in most localities is only a few feet above sea level. In both Forks, saline water is probably present beneath fresh water within the Magothy (?) formation at depths of a few hundred feet below sea level.

In Kings and Queens Counties, the occurrence of saline water is largely the result of salt-water encroachment caused by prolonged overpumping (fig. 1). In most places in these two counties, chloride concentrations are less than 1,000 ppm, but in northern Kings and northwestern Queens, water having a chloride concentration of 1,000 to 5,000 ppm was taken from several wells in the upper Pleistocene deposits and Jameco gravel at depths ranging from a few feet to about 200 feet (Lusczynski, 1952). Individual wells in this area yield several hundred gallons per minute.

Along the southern edge of the Island, sea water in the Magothy (?) formation and in the Lloyd sand member of the Raritan formation is offshore in most places. In the extreme southwestern part of Nassau County, however, it is found in an area of several square miles. There the high-chloride water occurs in a body that is several hundred feet thick in places and lies at depths below 300 feet in the middle and lower parts of the Magothy (?) formation. Water from one well screened at a depth of about 500 feet in the high-chloride water has about 30,000 ppm of dissolved solids. Water in a nearby well, screened at a depth of about 300 feet in the zone of diffusion between fresh water and sea water has a salinity of about 3,300 ppm. The chloride concentration in water from these two wells is about 16,000 and 1,900 ppm, respectively (tables 1 and 2; see also Geraghty, 1953). Whether this body of high-chloride water is actively encroaching is not fully known. However, if it is, the movement is slow. In the Magothy (?) formation, individual wells may yield as much as 1,500 gallons per minute (gpm).

Few data are available on the thickness of the zone of diffusion between fresh and high-chloride water—in other words, on the volume of saline water as here defined—beneath the land. Electric logs of several wells in Long Island suggest that the zone of diffusion between fresh and high-chloride water is on the order of 100 feet in width when measured normal to the interface.

At a few other places in Long Island, intermittent heavy pumping may cause an increase in chloride concentration in ground water locally in both the shallow and the deeper formations (Luszcysnki and Upson, 1954). The chloride concentration is usually less than 1,000 ppm; and at one locality, a variation in concentration suggests the alternate advance and recession of a diffusion zone or zones.

Saline Water in Staten Island

Chloride concentrations of pumped water in Staten Island (Richmond County) range from less than 100 to 1,550 ppm (tables 1 and 2; Perlmutter and Arnow, 1953). Saline ground water occurs in a few scattered areas near the shore, mainly in deposits of Pleistocene age. Wells in these deposits may yield as much as 700 gpm. Factors controlling the occurrence of saline water in Staten Island are similar to those described for Long Island.

Saline Water in Manhattan

The unconsolidated deposits in southern Manhattan (New York County) are open to sea water on three sides. Heavy seasonal withdrawals lower the water table sufficiently to allow saline water to reach the walls periodically. The chloride concentration of ground water pumped in this area ranges from about 100 to 10,000 ppm (tables 1 and 2; Perlmutter and Arnow, 1953).

Summary

Saline water, generally having a dissolved-solids content between 1,000 and 10,000 ppm, is limited largely to shoreline and offshore areas in Long Island, and has been observed as follows:

(1) Near the mouths of the many fresh-water streams,

(2) At shallow depths in the shore areas and along the barrier beaches,

(3) At moderate depths below fresh water in the North and South Forks of Suffolk County,

(4) Offshore, generally under natural conditions, in the intermediate and deeper formations around the perimeter of the Island, in the zones of diffusion between fresh water and sea water, and

(5) In certain inland areas in the shallow and intermediate formations where sea-water encroachment has resulted from heavy, continued overpumping.

Thus, Long Island considered as a whole has a sizable quantity of saline water which, if it can be demineralized economically, could prove useful for some purposes. However, utilization of saline water at any one locality in Long Island could not be on a large scale, because heavy sustained withdrawals probably would cause encroachment of the adjacent sea water.

UPSTATE NEW YORK

By

E. S. Asselstine and I. G. Grossman

General Relationships

In upstate New York (the area including and north of the Borough of Bronx in New York City), saline ground water occurs in several areas, here called interior areas, in which the formations consist wholly or partly of salt, gypsum, shale, limestone, and similar consolidated rocks; and in unconsolidated deposits along the lower reaches of the Hudson River. Although saline water occurs widely in these areas it is not a major problem so far as water supply is concerned because aquifers yielding fresh water also are generally present.

According to published reports and available analyses, saline water occurs in about half the counties of upstate New York. Water-Supply Paper 114, "Underground waters of eastern United States," lists 35 saline springs in 23 New York counties. Geological Survey Bulletin 32, "Mineral springs of the United States," lists 21 saline springs in 16 New York counties. In addition, analyses of 19 well waters from 12 counties made for the State-Federal program of ground-water investigations in New York show dissolved-solids concentrations exceeding 1,000 ppm. Table 4 lists 82 analyses from the counties for which such information is available. Table 3 gives the geologic formations tapped by these wells; well and other data also are listed. The areas included in the above lists overlap; moreover, analyses are unavailable for some samples said to be saline. Because of these duplications and omissions, the two tables list data from only 19 counties, although saline water has been reported in 29 of the 58 counties of the State.

Saline Aquifers

Available information shows that most wells yielding saline water are in four areas: (1) the Ontario lowland, south of Lake Ontario, (2) the southern tier, a linear group of counties bordering the Pennsylvania State line, (3) a northern belt flanking the Adirondack upland, and (4) an east-central area centering in Saratoga County.

The Ontario lowland is an east-west belt south of Lake Ontario and generally north of U. S. Highway 20. The area of saline ground water extends from Erie and Niagara Counties on the west through the Rochester area to southern Oneida County on the east. The water occurs in salt- and gypsum-bearing shale and sandstone of Silurian age. These are the salt-bearing Salina group and the iron-bearing Clinton group. In the central and western parts of the area they produce water containing unusual amounts of sulfate, chloride, iron, and other undesirable constituents. The formations are thinner to the east, and reports of saline water east of Syracuse are correspondingly fewer.

Rock-salt beds in the Salina group extend along an east-west line from Madison County to Erie County, a distance of 135 miles. The total area in New York underlain by rock-salt deposits is approximately 6,000 square miles. However, the strata dip toward the south, and this dip, together with the higher surface elevation to the south, makes their depth in the Allegheny Plateau area of southern New York generally greater than that reached by water wells. Hence, there are few or no data on possible yields of saline water.

Saline ground water is obtained also from unconsolidated deposits overlying the bedrock in scattered areas of the Ontario lowland, as shown in table 3. Five such wells in northern Seneca County yield an average of 33 gpm, the range being from 5 to 75 gpm. Doubtless the saline water has its source in the bedrock, but the manner and extent of actual encroachment of the saline water into fresh-water aquifers is not known and has not been investigated. An interesting use for saline water is reported from Lyons, Wayne County, N. Y. Natural brine from a 371-foot well that taps the Salina group is used to regenerate the ion-exchange material in a softener which treats hard water obtained from two nearby wells tapping glacial deposits.

Saline water in the southern tier of counties, bordering on the Pennsylvania State line, is obtained from sand and gravel of Pleistocene age and from underlying sandstone, siltstone, and shale of Devonian age. This east-west belt extends from Allegany County in the west to Delaware County in the east. It appears not to extend westward to the west edge of the State, along the strike of the beds, because recent analyses for Chatauqua and Cattaraugus Counties have failed to disclose saline water. A possibility that has not been confirmed is that some of the saline water in the southern tier is obtained from comminuted material of Silurian age carried southward by Pleistocene glaciers.

The third or northern area is a broad one extending from the St. Lawrence River southeastward along the flanks of the Adirondack upland. Little recent work has been done in this area, but in 3 of 9 wells for which information is available in the Watertown area of Jefferson County the water is saline. The water apparently is obtained from limestone of Ordovician age. The same bedrock underlies most of Jefferson County and parts of Lewis, Oneida, and Herkimer Counties. Thus, there is here a substantial area in which saline water may occur.

The fourth, or east-central, area where saline water is obtained, principally from flowing wells locally called springs, is in Saratoga County. Waters having similar characteristics have been found in wells drilled for water supply in adjacent Washington and Schenectady Counties. Saratoga Springs and Ballston Spa are the most important of many mineral "springs" in this area. The springs are associated with faults and occur along a narrow zone.

The waters from Saratoga and Ballston are unusual in that they have a high concentration of chloride and bicarbonate and practically no sulfate; also, they are charged with considerable carbon dioxide. Mineral water of this type is found in only a few places in the world (Cushing and Ruedemann, 1914). Published reports give differing theories to account for the origin of these waters, but the immediate source appears to be dolomitic beds of Ordovician (?) age. In Saratoga County, the yield of 6 recorded mineral wells, all within about 1.5 miles of each other, ranges from 1 to 150 gpm and averages 44 gpm. The daily production from these wells would be less then the arithmetic total of 346,000 gallons because the unrestricted flow from any one well reduces the yield of the nearby wells.

Hudson River

The Hudson River is a source of water supply for the city of Poughkeepsie and the U. S. Veterans Hospital at Castle Point. It was a standby source for the city of New York (Chelsea emergency pumping station completed in 1950 but never used). Available information from these users shows the dissolved-solids concentration in the river water to be less than 1,000 ppm, almost without exception. The intakes for these supplies are at or within 10 miles of Poughkeepsie.

South of Poughkeepsie the chloride concentration of the river water increases rapidly. A few wells in the valley that are adjacent to, and that obtain recharge from, the Hudson River have appreciable salinity. The actual concentration of dissolved solids varies with the discharge, tidal stage, and flow of the river. Only a few such wells are known in the area north of New York County (Manhattan). At Cold Spring in Putnam County one well only a few feet from the Hudson River reportedly yielded slightly saline water when pumped at 80 gpm during the autumn dry season. For most of the year the well yielded 80 gpm at low tide and 150 gpm at high tide with low salinity. Reports of water with a relatively high chloride concentration have been received from scattered localities along the Hudson River in Westchester County where heavy pumping has drawn in saline water from the river.

Summary

Saline water occurs in both consolidated and unconsolidated deposits in upstate New York, principally in four areas—the Ontario lowland, the southern tier of counties, and the northern and east-central areas. Saline water in unconsolidated deposits is found also along the lower reaches of the Hudson River. The bedrock formations that contain such water are predominantly shale and limestone of early Paleozoic age. Records of approximately 50 wells in bedrock, listed in table 3, show an average depth of 190 feet and an average yield of about 100 gpm. Records of 22 saline-water wells that end in unconsolidated deposits of all types show an average depth of 90 feet and an average yield of about 140 gpm.

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Table 1.—Records of wells and springs in Long Island, Staten Island, and Manhattan, N. Y.

(Use of water: D, domestic; S, stock; Ind., industrial; Irr., irrigation; N, none)

Number	Well or spring location	Owner	Depth of well (feet)	Diameter of well (inches)	Water-bearing formation	Reported water level: Below land surface (feet)	Reported water level: Date of measurement	Yield (gpm): Flow	Yield (gpm): Pump	Use of water	Date of collection of sample
K309	3 Willoughby St. Kings County	Horn and Hardart Co.	137	30-10	upper Pleistocene deposits	..	..	..	250	Ind	July 27, 1942
K318	17th St. and Surf Ave. Kings County	Tilyou Theatre	140	12	do.	..	..	..	350	Ind	Aug. 4, 1943
N3861	Sewage Plant, Village of Cedarhurst, Nassau Co.	U. S. G. S.	530	6	Magothy (?) formation	14.7	Jan. 18, 1954	..	130	N	Sept. 8, 1953
N3862	Sewage Plant, Village of Lawrence, Nassau Co.	do.	305	6	do.	4.9	do.	..	84	N	Sept. 18, 1953
Q1374	127th St. and 20th Ave., Queens County	Kleinert Rubber Co.	255	10	Lloyd sand member of Raritan formation	..	..	..	..	Ind	June 16, 1953
Ny61	269 Water St. Manhattan	Fulton Market Refrig. Co.	70	8	upper Pleistocene deposits	..	..	..	110	Ind	Mar. 7, 1940
R19	167 Edgewater St. Staten Island	Richmond Ice Co.	180	8	upper Pleistocene deposits (?)	15	..	..	75	Ind	May 1, 1945

Table 2.—Chemical analyses (and related physical measurements) of ground water in Long Island, Staten Island, and Manhattan, N. Y.

(Parts per million, except as indicated)

Number	Well or spring location	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH
K309	3 Willoughby St. Kings County	..	0.10	..	..	..	..	..	..	3,400	..	..	..	..	1,700	..	..	..
K318	17th St. and Surf Ave. Kings County	..	.30	..	..	..	..	..	..	14,800	..	..	..	..	5,750	..	..	..
N3861	Sewage Plant, Village of Cedarhurst, Nassau County	..	65	379	1,010	8,380	294	3.3	2,080	15,700	0.0	0.0	..	30,500	5,200	..	36,800	4.8
N3862	Sewage Plant, Village of Lawrence, Nassau County	..	135	250	147	525	15	.0	126	1,860	.0	.8	..	3,340	1,420	..	6,060	2.8
Q1374	127th St. and 20th Ave., Queens County	..	51	..	..	..	..	..	136	1,700	..	..	..	3,550	820	..	..	3.1
Ny61	299 Water St. Manhattan	..	.85	..	..	..	..	..	..	10,200	.1	..	..	..	4,000	..	..	..
R19	167 Edgewater St. Staten Island	..	7.5	..	..	..	.	..	..	1,550	.2	..	..	..	761	..	..	..

Table 3.—Records of wells and springs in upstate New York

(Use of water: D, domestic; Ind., industrial; N, none; Obs., observation; PS, public supply; S, stock)

Well or spring No.	Well or spring location	Owner	Depth of well (feet)	Diameter of well (inches)	Water-bearing material	Water level: Below land surface (feet)	Water level: Date of measurement	Yield (gpm)	Use	Temperature (°F)	Remarks
Bm 101	Binghamton	City of Binghamton	48.32	6	Pleistocene gravel	32.48	Aug. 31, 1946	..	Obs	54	Well constructed by U. S. Geol. Survey
Bm 105	do.	do.	143	6	Pleistocene deposits	19.70	Sept. 17, 1946	..	Obs	53	do.
Bm 106	do.	do.	74	6	do.	16.72	Sept. 23, 1946	..	Obs	57	do.
Cb 576	Bet. Catskill and Germantown	Henry Tratneck	140	6	Normanskill shale	25	....	5	D	..	
D 102	Walton	Middletown Milk & Cream Co.	420	8	Catskill formation	80	....	160	Ind	..	Used for cooling.
E 3	Buffalo	The Mentholatum Co.	110	8	Onondaga limestone	36	....	250	Ind	54	Used for air-conditioning.
E 23	do.	Spring Perch Co., Inc.	40	5	Skaneateles shale	16	....	29	Ind	53	
E 25	do.	W. & F. Manufacturing Co.	101	8	Onondaga limestone	37	....	60	Ind	52	Used for cooling.
E 27	do.	Buffalo Electro-Chemical Co., Inc.	130	12	Salina group	62	....	600	Ind	54-55	do.
E 29	do.	Fairmont Foods Co., Inc.	127	8	Onondaga limestone	..	....	200	Ind	55	do.
E 30	do.	Arctic Ice Co.	180	6	do.	20	....	300	Ind	54	do.
E 31	do.	Buffalo Steel Co.	77	10	Salina group	22	....	300	Ind	55-58	do.
E 39	do.	E. I. Dupont de Nemours & Co., Inc.	125	8	do.	30	....	500	Ind	..	Used for air-conditioning.
E 91	East Aurora Village	East Aurora Village	105	24-12	Pleistocene gravel	4.5	July 2, 1935	807	PS	..	
E 101	Buffalo	International Mineral & Chemical Corp.	120	6	Onondaga limestone	46	....	35	Ind	50	
G 456	Coxsackie Village	C. Beck	354	6	Normanskill shale	125	....	1	D	..	
G 477	Athens Village	F. Schmidt	75	6	do.	6	....	..	D	..	
G 512	Catskill Village	North American Cement Corp.	104	6	Helderberg group	36	....	10	D	50	
Lv 3	Mt. Morris	Birdseye-Snider, Div. of General Foods	107	12-8	Pleistocene gravel	15	....	..	Ind	..	
Mr 7048	Rochester	R. Schockow	70	6	Pleistocene deposits	..	....	..	S	53	
Mr 15026	Pittsford-Mendon Rd.	R. Johnson	179	6	Pleistocene deposits	..	....	30	S	..	Well flows.
Mr 15294	Rochester	P. Conti & Sons	110	..	Salina group	..	....	..	Ind	..	
Mt 251	Near Yosts	Veeder & Ouderkirk	315	8	Little Falls dolomite	26	....	40	D	55	
Mt 308	Fort Hunter	William Hovey	99	5	Pleistocene gravel	12	....	5.5	D	..	
Ni 8	Model City Road	Leonard Patton	65	6	Queenston shale	4	....	1	D	51	
Ni 22	Balmer Road, Youngstown	Ralph Cassford	58	36-6	Pleistocene deposits	11.65	June 10, 1948	..	D,S	49	
Ni 25	Lutts Road, Youngstown	Gordon McCormack	27	36	do.	12.79	June 18, 1948	..	D,S	52	

Table 3.—Records of wells and springs in upstate New York—(Continued)

Well or spring No.	Well or spring location	Owner	Depth of well (feet)	Diameter of well (inches)	Water-bearing material	Water level: Below land surface (feet)	Water level: Date of measurement	Yield (gpm)	Use	Temperature (°F)	Remarks
Ni 49	North Tonawanda	Durez Plastics & Chemicals, Inc.	105	12	Salina group	30	....	1100	Ind	50	Used for cooling.
Od 5	Syracuse	Muench Kreuzer Candle Co.	246	8	do.	45	....	70	Ind	56	Not used.
Od 7	do.	Peoples Ice Co.	240	8	do.	55	....	160	Ind	51-52	Used for refrigeration.
Od 14	do.	Onondaga Hotel	46	4	Pleistocene deposits	74.20	....	50	Ind	66	Used for air-conditioning.
Od 44	do.	Dey Bros. & Co.	85	12	do.	27	....	650	Ind	60-62	do.
Od 151	do.	N. Y. Telephone Co.	254	12-6	Salina group	26	....	110	Ind	61-67	Used for cooling.
Oe 9	Near Utica	A. C. Suppe	67	24-6	Clinton group	8	....	..	Ind	52	Used for bottling.
Oe 39	Yorkville	Toussaint Motor Sales Co.	154	6	Utica shale	7	....	4	D	..	
Oe 58	Rome	H. A. Smith	112	6	do.	12	....	4	D	..	
Oe 62	Utica	Floyd Sickler	150	6	Frankfort shale	35	....	2	D	..	
Oe 185	Rome	U. S. Govt., Griffiss Air Force Base	131	6	Utica shale	29	....	5	N	..	
Ot 108	Manchester Center	T. Page	24	6	Pleistocene gravel	..	....	75	D	51	
Ot 153	Clifton Springs Village	Clifton Springs Sanitarium	65	10-6	Cobleskill dolomite and Salina group	..	....	..	N	..	Well flows.
Ot 442	Manchester Township	William Finerghty	175	6	Salina group	30	....	2	..	..	
Ot 542	Palmyra Village	George Fox	82	6	do.	2	....	60	D	50	
Ot 570	Victor Township	C. Maier	121	6	Pleistocene till	..	....	5	D	..	
Ot 809	East side Canandaigua Lake	Earl Riafsteck	54	6	Genesee group and Geneseo shale	..	....	2	..	..	
Sa 83	Rexford	Edison Country Club	500	..	Schenectady formation	..	....	..	D	..	
Sa 87	Near Schenectady	Dr. Glen Smith	339	8	do.	35	....	3-5	D	..	
Sa 106	Stillwater Village	E. L. Rogers	85	6	do.	8	....	..	S	..	
Sb 614	Hornell Village	W. Brooks	111	6	Perrysburg formation	20	....	15	D,S	50	
Sb 1186	Savona	Bruno Balcer	75	6	Prattsburg sandstone and shale of Clarke (1903)	..	....	15	D	51	
Sb 1241	Hammondsport	Gerald Gleason	36	30	Pleistocene deposits	15.50	Aug. 15, 1950	..	D	51	
Sb 1248	Campbell	R. Seeley	88	6	Chemung formation	..	....	4	S	..	Well flows.
Se 19	Near Junius	Charles Albro	1600	10	Albion group	..	....	100	S	51	do.
Se 32	do.	Arthur McIvor	150	6	Salina group	18	....	5	D	..	
Se 70	Near Seneca Falls	E. S. Worden	30	..	Pleistocene deposits	7.73	June 10, 1947	15	D	50	
Se 81	do.	R. C. Deming	147	6	Salina group	50	....	20	S	..	
Se 119	Near Junius	F. J. Racine	178	6	Pleistocene gravel	65	....	30	D	..	

Table 3.—Records of wells and springs in upstate New York—(Continued)

Well or spring No.	Well or spring location	Owner	Depth of well (feet)	Diameter of well (inches)	Water-bearing material	Water level: Below land surface (feet)	Water level: Date of measurement	Yield (gpm)	Use	Temperature (°F)	Remarks
Se 126	Near Geneva	James Clise	268	6	Pleistocene till	20	....	75	D	..	
Se 127	Near Waterloo	E. M. Odell	20	36	Pleistocene sand	12	....	5	D	..	
Se 174	Near Seneca Falls	E. W. Sanders	33	6	Pleistocene deposits	9.6	June 21, 1947	5	D	48	
Se 180	Near Geneva	D. C. Doherty	187	6-4	Pleistocene sand	20	....	50	N	..	
Se 267	Near Seneca Falls	Carl Schuster	65	6	Salina group	32	....	9	S	..	
Se 503	do.	J. Souhan & Son	50	6	Manlius and Rondout limestone and Cobleskill limestone	20	....	15	Ind	..	
Se 14Sp	Near Canoga	R. Gibbs	..	..	Oriskany sandstone and Manlius limestone	..	....	34	D	50	
Sn 166	Princetown Township	Frank Lawrence	160	6	Schenectady formation	33	....	3	D	..	
Sn 337	Rotterdam Junction	Allen Eaton	465	6	do.	..	....	10	Ind	51	Used for medicinal purposes.
So 247	Cobleskill Village	Cobleskill Village	300	8	Becraft and Coeymans limestone	..	....	..	S	..	Well flows.
W 61	Near Fort Edward	Katherine Siaulonski	158	6	Snake Hill formation	11	....	10	D	..	
W 154	do.	Ennis Rozelle	247	6	do.	..	....	2-3	..	48	Well flows.
W 155	do.	John Germain	195	6	do.	..	....	3	S	..	do.
W 156	do.	George Tully	137	6	do.	20	....	6	D	..	
Wn 40	Sodus	Laurence Bros.	60	5⅝	Clinton group	10	....	½	S	..	
Wn 104	Macedon	Earl Rainbow	164	6	Salina group	12	....	20	Ind	58	
Wn 168	Clyde	Wayne Cheese Co.	185	6	do.	40	....	30	Ind	50	Used for cooling.
Wn 249	Near Savonnah	O. Ferris	65	6	do.	..	....	15	S	59	
Wn 280	Near Lyons	Irving Marsteimer	64	6	do.	22	....	3	D	..	
Wn 500	Near Clyde	Charles Jenkins	42	6	Pleistocene till	..	....	..	D	50	
Wn 546	Lyons	Lyons Village	371	8-6	Salina group	..	....	600	PS	..	

Table 4.—Chemical analyses of ground water in upstate New York

(Parts per million, except as indicated)

Well or Spring No.	Source of Analysis	Date Sample collected	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Alkalinity as $CaCO_3$	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Specific conductance (micromhos at 25°)	pH
Bm 101	N. Y. State Dept. of Health	8-30-46	..	39	..	..	..	..	..	75	81	12	..	..	1,040	180	..	6.8
Bm 105	do.	9-17-46	..	48	..	..	..	..	..	155	16	6.4	..	..	2,450	80	..	8.2
Bm 106	do.	9-19-46	..	420	..	..	..	..	..	173	16	2,000	..	..	9,770	124	..	8.0
Cb 576	do.	10- 2-47	..	9.0	..	..	..	..	..	334	1,540	11	..	..	2,840	1,700	..	7.2
D 102	do.	7- 2-46	..	.60	..	..	..	..	..	68	15	800	..	..	1,490	86	..	7.1
E 3	Unknown	4-30-40	..	..	552	21	5.5		422	..	1,160	32	..	..	2,020	1,470	..	6.9
E 23	U. S. Geol. Survey	6-11-51	17	.33a	184	41	58	5.2	501	..	185	104	0.0	0.3	841	628	1,320	7.1
E 25	N. Y. State Dept. of Health	6-19-51	..	.20	..	..	..	..	..	339	184	235	..	..	1,210	560	..	7.2
E 27	do.	6-19-51	..	3.6	..	..	..	..	..	123	1,050	120	..	..	2,120	1,350	..	6.8
E 29	U. S. Geol. Survey	6-18-51	14	5.6a	254	62	402	16	499	..	150	860	.5	.5	2,000	890	3,680	7.3
E 30	do.	6-19-51	15	.08a	212	124	197	13	500	..	560	350	.4	.4	1,720	1,040	2,310	6.8
E 31	do.	6-19-51	..	.15a	..	..	..	..	..	95	1,880	2,500	..	..	7,990	2,250	..	7.1
E 39	N. Y. State Dept. of Health	6-18-51	..	.10	..	..	..	..	..	110	1,230	94	..	..	2,210	1,450	..	7.1
E 91	U. S. Geol. Survey	6-19-51	13	1.4a	136	12	48	20	322	..	133	92	.2	.3	640	389	1,020	7.4
E 101	N. Y. State Dept. of Health	6-21-51	..	3.6	..	..	..	..	..	253	340	950	..	..	2,650	760	..	6.9
G 456	do.	12- 5-45	..	20	..	..	..	..	..	255	76	4.8	..	..	1,050	100	..	9.3
G 477	do.	2-29-45	..	1.0	..	..	..	..	..	428	421	15	..	..	1,120	260	..	7.7
G 512	do.	10- 3-52	..	.10	..	..	..	..	..	171	499	35	..	..	1,050	540	..	7.3
Lv 3	do.	7-25-46	..	.60	..	..	..	..	..	262	0	450	..	..	1,230	480	..	7.4
Mr 7048	do.	6-23-51	..	9.0	..	..	..	..	..	203	822	8.4	..	..	1,520	940	..	7.6
Mr 15026	U. S. Geol. Survey	7-28-51	19	1.4a	504	76	12	2.5	188	..	1,380	1.6	.2	1.4	2,100	1,570	2,210	7.4
Mr 15294	N. Y. State Dept. of Health	6-23-51	..	.80	..	..	..	..	..	162	529	4.0	..	..	1,050	620	..	7.5
Mt 251	do.	6-20-46	..	1.0	..	..	..	..	..	145	0	3,750	..	..	8,660	1,200	..	7.9
Mt 308	do.	10-17-46	..	1.3	..	..	..	..	..	153	7.2	460	..	..	1,230	400	..	7.9
Ni 8	U. S. Geol Survey	6-19-48	3.0	1.0a	521	65	2,340	41	9	..	3,620	2,100	1.0	12	8,920	1,570	11,900	5.7
Ni 22	do.	6-18-48	11	.79a	124	145	106	4.2	396	..	416	140	.2	150	1,390	906	1,990	8.2
Ni 25	do.	6-18-48	10	.14a	90	91	151	13	286	..	471	125	.4	8.4	1,160	599	1,700	8.3
Ni 49	N. Y. State Dept. of Health	6-20-51	..	.03	..	..	..	..	..	169	1,790	330	..	..	8,450	2,300	..	7.0
Od 5	do.	1-29-49	6.0	..	..	..	..	..	..	226	2,380	10,400	..	..	20,900	3,200	..	7.1
Od 7	U. S. Geol. Survey	4-13-53	7.0	.03a	368	78	10	4.4	370	..	840	64	.2	7.6	1,560	1,240	2,090	7.0

[a] Includes both iron in solution and precipitated iron.

Table 4.—Chemical analyses of ground water in upstate New York—(Continued)

(Parts per million, except as indicated)

Well or Spring No.	Source of Analysis	Date Sample collected	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Alkalinity as $CaSO_3$	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Specific conductance (micromhos at 25°)	pH
Od 14	N. Y. State Dept. of Health	4-14-53	..	.08	..	..	..	..	..	198	253	168	..	..	1,010	450	..	7.7
Od 44	do.	4-14-53	..	.60	..	..	..	..	..	324	578	1,200	..	..	2,950	980	..	6.8
Od 151	do.	4-13-53	..	3.0	..	..	..	..	..	321	1,160	152	..	..	2,460	1,600	..	6.8
Oe 9	do.	9-16-48	..	.18	..	..	..	..	..	158	<.3	4,000	..	..	9,110	430	..	7.4
Oe 39	do.	4-13-49	..	6.9	..	..	..	..	..	51	<.3	2,000	..	..	4,290	860	..	7.7
Oe 58	do.	4-13-49	..	.80	..	..	..	..	..	105	8.6	1,500	..	..	2,880	280	..	7.7
Oe 62	do.	1- 7-49	..	1.3	..	..	..	..	..	227	<.3	580	..	..	1,500	56	..	8.1
Oe 185	U. S. Geol. Survey	1-16-52	9.2	.03a	681	245	5330		145	..	.9	10,000	.7	79	16,200	2,710	24,300	7.3
Ot 108	do.	8-20-52	11	1.9a	246	55	5.5	2.4	304	..	584	12	1.1	.3	1,140	840	1,380	7.2
Ot 153	N. Y. State Dept. of Health	8- 7-49	..	.10	..	..	..	..	..	242	1,130	4.8	..	..	2,010	1,900	..	7.1
Ot 442	do.	2-14-50	..	17	..	..	..	..	..	14	1,280	3.0	..	..	2,250	1,020	..	6.8
Ot 542	U. S. Geol. Survey	8-22-52	12	12a	564	82	4.8	2.0	258	..	1,490	6.2	1.5	.4	2,360	1,740	2,440	7.1
Ot 570	N. Y. State Dept. of Health	3-31-49	..	7.0	..	..	..	..	..	300	991	8.8	..	..	1,870	1,300	..	7.1
Ot 809	do.	8- 2-49	..	.30	..	..	..	..	..	943	1.6	24	..	..	1,040	360	..	7.1
Sa 83	U. S. Geol. Survey	10-19-48	12	47a	338	208	79	10	474	..	1,450	5.6	.0	.2	2,500	1,700	2,750	6.9
Sa 87	do.	10-23-48	8.4	1.1a	10	6.5	1,370	8.0	2,940	..	3.6	420	1.7	1.1	3,380	52	5,270	7.9
Sa 87	do.	12-29-49	7.1	1.2a	7.5	4.7	1,200	10	2,690	..	1.2	400	2.0	.2	2,990	38	4,630	7.6
Sa 106	N. Y. State Dept. of Health	8- 8-47	..	3.5	..	..	..	..	..	550	131	60	..	..	1,360	900	..	6.9
Sb 614	do.	8-13-49	..	1.0	..	..	..	..	..	419	.3	850	..	..	1,710	240	..	7.3
Sb 1186	do.	8- 7-50	..	.30	..	..	..	..	..	322	699	8.0	..	..	1,620	1,100	..	7.1
Sb 1241	do.	8-12-50	..	.10	..	..	..	..	..	346	624	48	..	..	1,510	1,050	..	7.1
Sb 1248	do.	8-16-50	..	1.0	..	..	..	..	..	275	<.3	1,350	..	..	2,490	600	..	7.1
Se 19	do.	8-26-48	..	.8	..	..	..	..	..	225	1,380	5	..	..	2,670	1,520	..	6.9
Se 32	do.	10-23-48	..	.08	..	..	..	..	..	300	103	74	..	..	1,020	400	..	7.6
Se 70	do.	6-11-47	..	15	..	..	..	..	..	181	1,460	3.2	..	..	2,540	1,600	..	7.0
Se 81	do.	10-25-48	..	.25	..	..	..	..	..	264	918	5.4	..	..	1,840	920	..	7.2
Se 119	do.	10-25-48	..	7.8	..	..	..	..	..	152	1,310	3.6	..	..	2,250	1,300	..	7.3
Se 126	do.	10-23-48	..	6.6	..	..	..	..	..	123	1,610	1,000	..	..	4,450	880	..	7.4
Se 127	do.	6-17-47	..	.2	..	..	..	..	..	500	203	205	..	..	1,350	840	..	7.1
Se 174	do.	6-21-47	..	4.3	..	..	..	..	..	550	160	100	..	..	1,080	760	..	7.7

[a] Includes both iron in solution and precipitated iron.

Table 4.—Chemical analyses of ground water in upstate New York—(Continued)

(Parts per million, except as indicated)

Well or Spring No.	Source of Analysis	Date Sample collected	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Alkalinity as $CaSO_3$	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Specific conductance (micromhos at 25°)	pH
Se 180	do.	12-13-47	..	3.0	..	..	..	..	..	96	1,730	125	..	..	2,730	1,900	..	7.4
Se 267	do.	8- 9-47	..	2.7	..	..	..	..	..	287	1,170	3.8	..	..	2,190	1,650	..	7.1
Se 503	N. Y. State Dept. of Health	10-23-48	..	1.4	..	..	..	..	..	239	915	57	..	..	1,840	1,000	..	6.9
Se 14Sp	do.	10-25-48	..	.25	..	..	..	..	326	..	1,020	170	..	..	2,180	940	..	7.1
Sn 166	do.	6-14-46	..	1.0	..	..	..	..	434	..	.0	450	..	..	1,140	6.0	..	8.9
Sn 337	U. S. Geol. Survey	10-30-50	22	43a	1,190	576	6,120	296	5,050	..	0	10,800	3.0	1.6	21,700	5,340	29,300	6.2
So 247	N. Y. State Dept. of Health	11-19-45	..	2.0	..	..	..	..	..	240	434	140	..	..	1,160	580	..	7.4
W 61	do.	12-14-45	..	4.5	..	..	..	..	..	870	1,250	210	..	..	3,150	1,700	..	6.8
W 154	Unknown	2- 6-46	..	9.6	..	..	..	..	5,060	..	2,770	567	..	..	8,890	5,180	..	..
W 155	N. Y. State Dept. of Health	2- 6-46	..	1.5	..	..	..	..	..	1,450	0	330	..	..	2,020	566	..	6.9
W 156	do.	2- 6-46	..	45	..	..	..	..	..	2,100	7.0	480	..	..	3,080	450	..	6.9
Wn 40	do.	9-25-48	..	.6	..	..	..	..	..	231	88	56	..	..	1,700	960	..	7.3
Wn 104	do.	10-17-47	..	.03	..	..	..	..	..	121	2,210	675	..	..	4,760	2,600	..	8.2
Wn 168	U. S. Geol. Survey	5-24-49	9.4	2.5a	608	122	985	..	160	..	2,200	1,230	1.2	2.0	5,490	2,020	6,706	8.0
Wn 249	N. Y. State Dept. of Health	10-14-47	..	1.5	..	..	..	..	..	207	1,320	8	..	..	2,350	1,600	..	7.1
Wn 280	do.	11- 5-47	..	.6	..	..	..	..	..	220	1,170	215	..	..	3,450	2,100	..	7.2
Wn 500	do.	7-28-48	..	9.3	..	..	..	..	..	184	1,590	48	..	..	3,040	1,500	..	7.2
Wn 546	Unknown	..	..	5.0	2,200	655	..	..	..	74	2,550	21,000	..	..	..	8,200	..	..

[a] Includes both iron in solution and precipitated iron.

REPORTS DEALING WITH GROUND-WATER CONDITIONS IN NEW YORK PUBLISHED BY THE NEW YORK STATE WATER POWER AND CONTROL COMMISSION AND PREPARED IN COOPERATION WITH THE U. S. GEOLOGICAL SURVEY

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*GW- 1. Withdrawal of Ground Water on Long Island, N. Y.; D. G. Thompson and R. M. Leggette. 1936.

GW- 2. Engineering Report on the Water Supplies of Long Island; Russell Suter. 1937.

*GW- 3. Record of Wells in Kings County, N. Y.; R. M. Leggette and others. 1937.

*GW- 4. Record of Wells in Suffolk County, N. Y.; R. M. Leggette and others. 1938.

*GW- 5. Record of Wells in Nassau County, N. Y.; R. M. Leggette and others. 1938.

*GW- 6. Record of Wells in Queens County, N. Y.; R. M. Leggette and others. 1938.

*GW- 7. Report on the Geology and Hydrology of Kings and Queens Counties, Long Island; Homer Sanford. 1938.

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GW-33. The Ground-Water Resources of Washington County, N. Y.; R. V. Cushman. 1953.

GW-34. The Ground-Water Resources of Greene County, N. Y.; Jean M. Berdan. 1954.

GW-35. The Ground Water Resources of Westchester County, N. Y., Part 1, Records of Wells and Test Holes; E. S. Asselstine and I. G. Grossman. 1955.

GW-36. Saline Waters in New York State; N. J. Lusczynski, J. J. Geraghty, E. S. Asselstine, and I. G. Grossman. 1956.

GW-37. The Ground Water Resources of Putnam County, N. Y.; I. G. Grossman. 1957.

An asterisk (*) indicates that the report is out of print, but such reports are available for consultation in certain libraries.